"Upgraded Coal Interest Group"

Final Technical Report

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Abstract

The Upgraded Coal Interest Group (UCIG) is an EPRI "users group" that focuses on clean, low-cost options for coal-based power generation. The UCIG covers topics that involve (1) pre-combustion processes, (2) co-firing systems and fuels, and (3) reburn using coal-derived or biomass-derived fuels. The UCIG mission is to preserve and expand the economic use of coal for energy. By reducing the fuel costs and environmental impacts of coal-fired power generation, existing units become more cost effective and thus new units utilizing advanced combustion technologies are more likely to be coal-fired.

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List(s) of Graphical Materials

None.

Executive Summary

High-efficiency combustion and conversion systems that will reduce emissions produced by the use of coal to generate electric power are under development but are not likely to be employed in the next ten years. In order to improve ambient air quality in the U.S. during this transition period and maintain low electricity costs, higher-quality/lower-cost coal and coal-based fuels are required. Therefore, it is important in the near term to continue and perhaps increase research on coal and coal-based fuels and emission controls for existing power plants. This can help reduce the trend toward reliance on natural gas for new power generation in order to reduce emissions and will help maintain fuel diversity for power production in the United States.

Introduction

The mission of the Upgraded Coal Interest Group (UCIG), which is an EPRI "users group" that focuses on clean and low-cost options for coal-based power generation via pre-combustion, co-firing and reburn options, is to preserve and expand the economic use of coal as a locally and nationally valuable energy resource. By reducing the fuel costs and environmental impact on coal-fired power generation, existing units become more cost effective and thus new units utilizing advanced combustion technologies are more likely to be coal-fired. Natural gas is a premium fuel that is better reserved for high value and transportation purposes. This overview summarizes many of the projects most recently funded by the UCIG.

Results and Discussion

1. REMOVAL OF "TRI" TRACE METALS VIA ADVANCED COAL CLEANING

"TRI" refers to "toxic release inventory" and the metals of interest include mercury, selenium, and arsenic (Hg, Se, and As). The project assesses the potential for trace element removal by advanced coal cleaning: new coal cleaning processes that may remove trace metals as well as the usual ash and sulfur. The contractor is CQ Inc. TVA and EPRI are directing the choice of the processes (new, "advanced" ones) and the coals to be the subjects. Metals covered are Hg, Se, As, and others.

2. COMPOSITE FUELS: BIOMASS/WASTES/COAL BLENDS

In a co-funded project, with DOE as the major funder and CQ Inc. as the contractor, started in February 1999 to design and test a "dewatering die" capable of making strong, durable pellets from a combination of coal, biomass-derived wastes and plastic-derived wastes. The dewatering die work by CQ Inc. is complete and was not carried into DOE Phase 2. However, DOE Phase 2 work has been funded by DOE and started by CQ Inc. This Phase 2 effort is further development of a biomass-coal composite for coal-fired pulverized fuel boilers. The fuel blending process that will be tested in Phase 2 is the Granuflow process developed by DOE-NETL and licensed to CQ Inc. by DOE. In the ongoing project production of the fuel will be optimized and production runs made to produce one to three large samples of the fuel. The production runs will test and improve the production performance and economics. Combustion properties and handling properties will be evaluated.

3. COAL-CLEANING TECHNOLOGY APPLIED TO CARBON RECOVERY FROM ASH AND COAL-CLEANING WASTES

This is a project of the CPCPC (Consortium for Premium Carbon Products from Coal) an industry-led, industry/DOE-cofunded program conducted for DOE and industry by Penn State University and contractors or grantees selected by the CPCPC and managed by PSU.

First approved by UCIG and the CPCPC as coal cleaning technology applied to recover carbon from coal fly-ash, using the Carbon+ Inc. approach, the project was redeveloped in 2002 by the CPCPC, PSU and Reliant Energy to test the capacity to recover high value from both fly-ash and coal-cleaning waste fines at Homer City PA.

4. BIOSOLIDS FUEL FOR COFIRING: A HYDROTHERMALLY TREATED SEWAGE SLUDGE OR OTHER BIOMASS-BASED SLURRY FUEL FOR PULVERIZED-COAL-FIRED (PC) BOILERS

A continuation and expansion of the hydrothermal sewage sludge project has been proposed to UCIG by Adelphi U. and the Dooher Institute, but was not funded by UCIG.

5. HAPPs (HAZARDOUS AIR POLLUTANT PRECURSORS): REMOVAL VIA ON-LINE DRY MAGNETIC SEPARATION

Measurements combined with a model to estimate the extent of removal of mercury, arsenic, selenium, and other trace contaminants in coal by means of the "MagMill" process which is on-line coal cleaning, using magnetic properties of pyrite to clean sulfur and ash out of coal, with potential to increase pulverized throughput and reduce pulverized wear via selective removal of hard ash. DOE cofunding was obtained as a Phase 1 project and the report has been distributed to UCIG members. The report sent to UCIG members was the same as sent to DOE by EXPORTech, the contractor. Phase 2 funding was not available from DOE to continue this into the hardware phase.

6. BIOFUEL FOR COFIRING: A HYDROTHERMALLY TREATED SEWAGE SLUDGE SLURRY FUEL

Adelphi University (and the new Dooher Institute of Physics and Energy) completed a report for UCIG on tests and calculations to assess and optimize an application of the EnerTech hydrothermal carbonization process. EnerTech, based near Atlanta GA, is building a pilot plant, cofunded through a major competitive award from DOE, in Kearney NJ. This application is the processing of sewage sludge into a sanitary slurry fuel suitable for being cofired with coal and/or coal/water slurry in coal-fired power boilers. Included in the report is

a design/cost study of the slurry flow properties and description of a concept for optimized cofiring of the sludge-derived slurry in coal fired power plants.

7. COMPOSITE FUELS: BIOMASS/WASTES/COAL PELLETIZED FUEL FOR PC BOILERS

In a co-funded project, with DOE as the major funder and CQ Inc. as the contractor, work began in February 1999 to design and test a "dewatering die" capable of making strong, durable pellets from a combination of coal, biomass-derived wastes and plastic-derived wastes. The dewatering die work by CQ Inc. is complete. The work to develop and improve the dewatering die was not carried into the DOE Phase 2 project. The Phase 1 report was distributed to UCIG members, and delivered to DOE. This report covers design, cost and performance data on the fuel preparation process, fuel resources, fuel properties and the combustion performance of three pelletized blends made from (1) coal plus biomass, (2) coal plus waste plastic, and (3) coal plus sewage sludge.

8. BIOMASS COFIRING

The Seward Project to build and test a woodwaste fuel (sawdust) cofiring operation at Seward, Pennsylvania was completed and reported in 2001. Biomass fuel systems were designed and installed at 32MW and 147MW pulverized coal boilers at Seward Station near Johnstown, PA. Reports on design, costs and 32-MW test results were prepared and distributed in 1999 and 2000. The 10-MW fuel system (for the 147-MWe unit was moved to Allegheny Energy Supply's Albright station and was tested there in 2001. The final construction was at Albright, West Virginia, because the small unit at Seward was not being run and the larger unit at Seward was not available. The design and cost data, plus the performance results from the first tests were reported to DOE by the contractor Foster Wheeler. This report is available to UCIG members from the EPRI Biomass Energy program, through Evan Hughes, 1-650-855-2179, ehuahes@eori.com. The biomass fuel studied and tested included sawdust at 50% moisture, i.e., green sawdust, and sawdust at lower moisture levels, often a blend at about 30% moisture. The biomass fuel was cofired with pulverized coal via a separation feed stream for the wood fuel.

9. COAL-WATER AND OTHER SLURRY FUELS

Process and cost analyses of coal-water slurry (CWS) and also an upgraded sewage sludge product generated as a slurry fuel (thermally treated and carbonized). The resulting sewage sludge slurry is an upgraded slurry fuel, comparable to CWS. Full-scale boiler, tests of cofired coal plus CWS have been conducted. Engineering resources and market economic and market assessments have been done on CWS and on CSSS (carbonized sewage sludge slurry). Several reports have been distributed to UCIG members.

10. COMPOSITE FUELS AND BIOMASS FUELS

Preparation design, cost and performance data on fuel preparation process, fuel resources, fuel properties and the combustion performance of pelletized fuels made from coal, coal plus biomass and coal plus wastes such as plastic, paper sludge, etc. Several reports have been completed. A cofunded project with DOE as the major funder was begun in February 1999 to design and test a "dewatering die" capable of making strong, durable pellets from a combination of coal, biomass-derived wastes and plastic-derived wastes. The dewatering die work by CQ Inc. is complete and was not carried into DOE Phase 2. However, DOE Phase 2 work was funded by DOE and started by CQ Inc to encompass the further development of a biomass-coal composite for coal-fired pulverized fuel boilers.

11. BIOMASS COFIRING

Woodwaste fuels--including 50% moisture, green sawdust--cofired with pulverized coal via a separation feed stream for the wood fuel. A biomass fuel system designed and installed at 32MW and 147MW pulverized coal boilers at Seward Station near Johnstown, PA. Reports on design, costs and 32MW test results are available. The 10MW fuel system was moved to Allegheny Energy Supply's Albright station.

12. HAPPs REMOVAL via COAL PREPARATION

Data on hazardous air pollution precursors (HAPPs) presence in coals and the estimated removal amounts and removal costs when coal cleaning processes are applied. Reports are available, showing coal cleaning circuits and estimates of costs to clean out HAPPs.

13. RESOURCES/PROCESSES FOR COAL WASTES & LOW-RANK COALS UPGRADED AS FUELS

Resource assessments, process descriptions, test results and design cost studies on pond fine wastes wet coals, low-rank coals, etc. being upgraded via dewatering, drying ash removal wastes etc. Several reports are available. A recent test by SIGECO of an air jet process to both dewater and pulverize coal and coal pond wastes was reported to the UCIG members in 2000. Another process, Granuflow (flowable/dry/dustless agglomerated coal fines), developed by DOE-NETL will be tested in a future project approved by UCIG members. This will involve a production-scale test run to optimize and prove full-scale production in a coal fines processing plant. Work is being done by CQ Inc. and DOE-NIX, as described above under continuing projects.

14. FIELD TEST RESULTS

This includes (1) coal water slurry cofiring at cyclone and pulverized coal boilers; (2) "MagMill" (on-line dry magnetic separation of ash, S, trace metals and any pyrite-related materials) tests in a modified pulverizer; and (3) wood waste (sawdust) cofiring at 10% by heat in a PC boiler. Various test data and interpretation reports and papers are available.

15. COAL WATER SLURRY DATA AND LAB TESTS

A database has been developed and slurry preparation technologies have been described and evaluated in the laboratory at PSU using special equipment for coal slurry properties and testing.
Advanced dewatering and slurry preparation processes have been tested and reported to UCIG. The report has been distributed to UCIG members.

Conclusion

EPRl acknowledges and thanks DOE-NETL (the National Energy Technology Laboratory) for the cofunding support to UCIG provided in 2001 and for providing the site of all three meetings in 2001, at the Pittsburgh campus of NETL. Carl Maronde of the DOE Fossil Energy "Solid Fuels and Feedstocks Program" has been the Program Manager for the NETL participation and co-sponsorship of the EPRl Upgraded Coal Interest Group (UCIG).

In addition, EPRl acknowledges the technical and administrative support provided by Joe Battista of Cofiring Alternatives in Ebensburg, Pennsylvania, as the consultant to EPRl for the UCIG program. Carole Stokes of the Generation unit at EPRl has provided administrative assistance at the EPRl headquarters in Palo Alto, CA, and has prepared the meeting notebooks and, with Joe Battista, the annual reports. Evan Hughes, Manager, Biomass Energy, at EPRl is the EPRl project manager for UCIG.

References

None.

Bibliography

None.

List of Acronyms and Abbreviations

- DOE-NETL – Dept of Energy, National Energy Technology Laboratory
- EPRI – Electric Power Research Institute
- UCIG – Upgraded Coal Interest Group
- TRI – Toxic Release Inventory
- TVA – Tennessee Valley Authority
- CPCPC – Consortium for Premium Carbon Products from Coal
- PSU – Penn State University
- HAPPs – Hazardous Air Pollutant Precursors
- CWS – Coal-Water Slurry
- CSSS – Carbonized Sewage Sludge Slurry